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Monitoring the range of ecological variability in burned and unburned streams of the Frank Church 'River of No Return' Wilderness during 1997

Prepared For:

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David Burns
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Dear Dr. Burns,

Enclosed you will find a copy of our final report for the 1997 field season entitled Monitoring the range of ecological variability in burned and unburned streams of the Frank Church 'River of No Return' Wilderness during 1997.

If you have any questions or comments please contact either Kate Bowman at (208) 236-2139, or G. W. Minshall at (208) 236-2236.

Sincerely,

Kathryn Bowman

Kathryn Bowman

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SUMMARY

This report presents the results of our research conducted for the Payette National Forest during 1997. As in the past, our research was conducted on Big Creek and its tributaries inside the Frank Church Wilderness Area. These streams have been influenced by various wildfires since 1988. The effect of wildfires on stream ecosystems has been the focus of our research over the past several years (see Royer et al. 1995, Royer and Minshall 1996).

In general, no substantial changes in water chemistry of the streams have been observed in Big Creek or its tributaries during the nine year period. Similarly, measurements of physical habitat characteristics have not displayed any consistent pattern over the course of the study. It appears that the Golden Fire has not, to date, been a major influence on the physical and chemical habitat of Cliff, Cougar, or Goat Creeks. The Rush Point Fire also appears to have not significantly affected the physical and chemical habitat of Rush or Pioneer Creeks.

Corresponding with the relative stability of the stream's physical and chemical habitat, the biotic components of the study also have not displayed any consistent evidence for effects of fire on these streams. Periphyton has not shown any substantial changes in either chlorophyll-a or biomass/m^2. Because the habitat has not been altered substantially, it is not surprising that the benthic macroinvertebrate community metrics have also remained fairly consistent during the nine year study period. Macroinvertebrate density, biomass, species richness and Simpson's Index have not been significantly affected by the Golden or Rush Point Fires.

The collection of baseline data and the description of natural variation in ecological conditions is another major goal of this research. In this regard, macroinvertebrate density and taxa richness appear to be useful metrics for describing the natural variation in the structure of macroinvertebrate communities in these streams. The several years of data from Cliff, Rush, Pioneer, and Cougar Creeks indicates that relatively stable long-term means exist for both density and taxa richness. The severity of future disturbances may be determined by examining changes in the density and/or number of taxa, relative to the long-term mean in a given stream.

INTRODUCTION

Our primary research goal during 1997 was (1) to continue monitoring tributaries to Big Creek that we had examined in previous years; and (2) to sample Big Creek which has not been sampled 1988. These streams have been examined in relation to the role of wildfire in structuring benthic habitat and invertebrate communities in the Payette National Forest (Royer and Minshall 1996, Royer et al. 1995). The studies in the Big Creek catchment were designed to examine the influence of the 1988 Golden Fire and the 1991 Rush Point Fire. To date, the effects of these wildfires on stream invertebrate communities have been inconclusive, with no clear and discernable patterns emerging over several years of study. However, these streams are an important for wilderness monitoring because they represent a wide range of pristine stream types and the moderate number of streams sampled helps to determine the natural variability found in relatively pristine stream ecosystems. For all streams examined, the results provide baseline habitat and macroinvertebrate data against which the effects of future disturbances (natural or anthropogenic) can be measured..

The study streams are located within the Payette National Forest in central Idaho along Big Creek in the Frank Church 'River of No Return' Wilderness Area (Table 1). They flow through steep valleys with forested slopes of primarily Douglas-Fir and Ponderosa Pine, also present are extensive bare or sparsely vegetated areas. Open areas of grass and sagebrush are common on the drier slopes in both catchments. The majority of the annual precipitation occurs as snow, resulting in peak flows from late spring through mid-summer. The streams generally remain at baseflow conditions from late summer through autumn.

Study streams in the Big Creek catchment were influenced, to varying degrees, by either the Golden Fire of 1988 or the Rush Point Fire of 1991. The upper portions of the Cliff and Cougar were affected by the Golden Fire; Goat Creek was not burned by the wildfire, but rather by an intentional "back-burn" of the riparian vegetation, also in 1988. Cave Creek serves as a reference for these sites. All of the above streams have a southern aspect. The upper portion of the Rush and Pioneer Creek catchments were minimally influenced by the Rush Point Fire and

Table 1. Location and general characteristics of the study streams in the Big Creek catchment. All are located in T20N, R13E except for Cave Creek which is located in T21N, R12E.

Stream	Elevation (m)	Longitude	Latitude	Order	Link	Slope (%)
Rush Creek	1170	114^0 51' W	45^0 07' N	5	223	1
Pioneer Creek	1165	114^0 51' W	45^0 06' N	3	18	3
Cave Creek	1220	114^0 57' W	45^0 08' N	3	41	6
Cliff Creek	1195	114^0 51' W	45^0 07' N	2	10	13
Goat Creek	1125	114^0 48' W	45^0 07' N	2	6	18
Cougar Creek	1095	114^0 49' W	45^0 07' N	3	14	12
Big Creek	1150	114^0 50' W	45^0 06' N	6	890*	1

*approximate

have northern aspects. Thus, they provide a comparison with the south-facing streams noted above.

METHODS

Physical, chemical, and biological parameters were measured in all streams. Measurements of the physical habitat of the channel and water constituents provide important information about current stream conditions and are especially useful in year-to-year comparisons. Biological monitoring gives an indication of past as well as current ecological conditions. All sites were sampled during July 20 to 24, 1997. Field methods used for the various portions of this study are summarized in Table 2. The methods are consistent with those used in our previous studies of wildfire and wilderness streams. These are relatively routine in stream ecology and are described in detail in standard reference sources (Weber 1973, Greeson et al. 1977, Lind 1979, Stednik 1991, Merritt and Cummins 1996, APHA 1992, Platts et al. 1983, Davis et al. *in press*). Mean substratum size, water depths, and embeddedness were determined at 100 random locations along a substantial (ca. 200 meter) reach of stream.

Procedures for sample analysis are described briefly in Table 2. Several metrics (density, biomass, taxa richness, and Simpson's Index) were determined for the macroinvertebrate communities for all sites and years. In addition, rankings of the 15 most abundant taxa at each site were used to evaluate year-to-year stability of the communities.

RESULTS

In general, no substantial changes in water chemistry of the streams have been observed (Table 3). Similarly, the measurements of physical habitat in the streams have not varied in any consistent manner over the course of the study (Table 4). The heavy runoff that occurred during the spring and early summer of 1997 may have scoured the streams and altered benthic habitat, but evidence of this in our measurements is sparse. For example, Goat was the only stream to show a significant change in physical habitat between 1996 and 1997 (Table 4). Goat

Table 2. Summary of variables, sampling methods, and analytical procedures used in the study.

Variable	Type*	Sampling Method	Analytical Method
A. Physical			
Temperature	P	Field measurement	Thermometer
Substratum Size	R	Measure x-axis of 100 randomly selected substrata	Calculate mean substratum size
Substratum Embed-dedness	R	Visual estimation on 100 randomly selected substrata	Calculate mean substratum embeddedness
Stream Width	T	Measure bank-full width using a nylon meter tape	Calculate mean stream width
Stream Depth	R	Measure water depth at the 100 randomly chosen substrata	Calculate mean water depth
Discharge	T	Velocity/depth profile Velocity measured with a small C-1 Ott meter	Q=WxDxV; where Q=discharge, W=width, D=depth, and V=vel
B. Chemical			
Conductivity	P	Field measurement	Temperature comp-ensated meter (Orion model 126)
pH	P	Field measurement (Orion model 250/A)	Digital meter
Alkalinity	P	Single water sample	Methyl-purple titration
Hardness	P	Single water sample	EDTA titration
C. Biological			
Invertebrates	R	Collect 5 samples using a Surber sampler	Remove invertebrates, identify, enumerate, and analyze
Periphyton	R	Collect samples from 5 individual substrata	Methanol extraction

* P=point measure; T=transect across stream; R=random throughout a defined reach.

Table 3. Discharge and chemical measures for the study streams in the Big Creek catchment.

Stream	Year	Discharge (m3/s)	Alkalinity (mg CaCO3/L)	Hardness (mg CaCO3/L)	Conductance (uS/cm @ 20C)	pH
Rush	1988	1.61	36	30	110	7.8
	1991				103	8.2
	1992	1.10	46	46	95	8.4
	1993	0.31				7.9
	1994	1.56			77	
	1995	1.75	32	57	76	8.2
	1996	1.59	36	80	99	8.5
	1997	1.94	30	65	85	7.4
Pioneer	1990	0.16	62	86	88	8.1
	1991	0.01			125	8.0
	1993	0.02	26	48	72	
	1994	0.17			113	
	1995	0.21	42	81	135	7.9
	1996	0.11	40	70	119	7.7
	1997	0.16	36	77	108	8.1
Cave	1990	0.31	24	44	39	7.9
	1993	0.08	19	24	55	
	1994	0.21				
	1995	0.17	20	40	48	8.1
	1996	0.22	44	48	66	7.8
	1997	0.29	20	36	64	7.9
Cliff	1988	0.04				
	1990	0.32	35	66	61	8.2
	1991	0.18	77	71	73	8.2
	1992	0.08	48	49	99	8.0
	1993	0.09	26	44	77	7.7
	1994	0.10			79	
	1995	0.15	34	53	93	8.2
	1996	0.14	32	42	105	7.3
	1997	0.17	24	57	86	8
Goat	1990	0.01	86	110	139	8.1
	1991	0.09	49	51	153	8.4
	1992	0.01	80	76	151	8.2
	1993	0.01	41	68	116	8.1
	1994	0.01			148	
	1995	0.01	56	93	140	8.1
	1996	0.04	50	68	157	8
	1997	0.03	48	89		
Cougar	1990	0.11	46	71	70	8.5
	1991	0.10	36	32	93	7.4
	1992	0.01	59	60	113	8.2
	1993	0.02	33	48	94	7.7
	1994	0.08				
	1995	0.10	48	85	107	8.2
	1996	0.15	52	80	158	8.2
	1997	0.13	44	89		
Big Creek	1988	8.83				
	1997	7.24	24	52.5	93.4	7.7

Table 4. Habitat heterogeneity measures for study streams in the Big Creek catchment. SD = standard deviation, CV = coefficient of variation.

		Substrate Size (cm)			Substrate Embeddedness (%)			Bankfull Width (m)		Baseflow Depth (cm)	
Stream	Year	mean (n=100)	SD	CV	mean (n=100)	SD	CV	mean (n=5)	SD	mean (n=100)	SD
Rush	1988	14.6	14.0	0.96				15.1		35.0	10.0
	1992	13.3	9.2	0.69	18.8	26.7	0.96	12.0		21.0	10.0
	1993	21.3	14.8	0.69	35.0	28.9	0.51	13.4	1.5	26.2	7.3
	1994	13.9	13.2	0.95	39.3	34.0	0.46	6.3	4.8	26.2	7.9
	1995	22.6	16.7	0.74	25.0	26.2	1.05	11.8	0.6	35.0	10.3
	1996	21.0	20.0	0.95	30.0	36.0	1.20	13.9	2.4	25.4	15.0
	1997	18.0	17.0	0.94	38.0	28.0	0.74	12.1	1.2	27.0	14.0
Pioneer	1990	16.7	14.0	0.84	12.5	23.9	1.44	3.4		16.0	4.5
	1993	19.5	18.7	0.96	33.8	28.8	0.53	2.9	0.9	15.3	7.7
	1994	13.9	15.2	1.09	34.3	33.7	0.53	1.7	4.2	18.0	7.9
	1995	15.2	17.4	1.14	45.3	36.3	0.80	3.0	0.6	17.5	10.1
	1996	17.0	20.0	1.18	44.0	40.0	0.91	2.7	0.5	14.7	9.3
	1997	18.0	17.0	0.94	20.0	28.0	1.40	2.6	0.6	17.0	9.0
Cave	1990	18.8	12.2	0.65				6.1		15.0	6.0
	1993	18.2	17.0	0.93	59.8	29.8	0.30	5.4	0.5	15.3	8.1
	1994	18.3	15.9	0.87	45.0	33.9	0.40	4.1	8.1	15.6	9.5
	1995	15.1	18.7	1.24	56.5	33.1	0.59	5.2	1.2	18.8	7.9
	1996	16.0	11.0	0.69	14.0	21.0	1.50	5.0	0.8	15.7	9.7
	1997	15.0	11.0	0.73	23.0	26.0	1.13	5.1	1.0	20.0	11.0
Cliff	1988	16.2	10.2	0.63				4.8			
	1990	25.3	17.7	0.70				3.5		20.0	4.0
	1991	22.5	20.3	0.90				3.8		20.0	8.0
	1992	26.8	26.8	1.00				5.5		20.0	14.0
	1993	21.5	16.8	0.78	41.8	31.6	0.43	3.2	0.7	16.4	8.3
	1994	19.5	16.3	0.84	40.9	30.8	0.44	2.0	6.4	20.9	10.2
	1995	21.5	24.4	1.13	66.0	73.4	1.11	3.5	0.7	22.1	10.7
	1996	21.0	27.0	1.29	41.0	39.0	0.95	4.2	1.5	11.1	8.1
	1997	20.0	15.0	0.75	19.0	23.0	1.21	3.0	0.3	18.0	10.0
Goat	1990	9.7	16.5	1.70				0.9		10.0	2.0
	1991	10.9	16.4	1.50				0.9		10.0	3.0
	1992	13.1	17.0	1.30				0.8		10.0	7.0
	1993	17.5	16.6	0.95	43.8	35.4	0.41	1.1	0.3	12.0	4.1
	1994	11.7	16.1	1.38	68.5	31.1	0.26	0.9	0.2	10.4	4.4
	1995	12.0	14.0	1.16	65.3	34.5	0.53	1.2	0.3	10.8	5.7
	1996	24.0	27.0	1.13	55.0	37.0	0.67	1.3	0.2	5.9	4.1
	1997	7.0	10.0	1.43	11.0	20.0	1.82	0.8	0.7	12.0	5.0
Cougar	1990	21.6	13.0	0.60				2.7		20.0	
	1991	22.6	27.1	1.20				3.1		20.0	6.0
	1992	13.0	14.3	1.10				2.6		20.0	20.0
	1993	21.1	20.9	0.99	42.5	30.5	0.42	2.5	0.9	16.3	8.1
	1994	15.5	11.9	0.77	50.3	33.8	0.36	1.6	0.7	18.8	10.3
	1995	19.2	17.1	0.89	47.5	31.5	0.66	2.5	0.6	20.3	11.3
	1996	20.0	24.0	1.20	46.0	39.0	0.85	2.8	0.5	12.7	8.0
	1997	18.0	14	0.78	18.0	23	1.28	2.7	0.7	18.0	10
Big Creek	1988	19.5	13.0	0.67				43.2			
	1997	24.2	17.8	0.74	13.0	22.1	1.58	43	3.1	55.7	23

was slightly narrower and deeper. Mean substrate size decreased and substrate embeddedness was 30% lower than any other year. A substantial decrease in substrate embeddedness also was measured in Cougar, Cliff, and Pioneer Creeks possibly indicating scouring flows. However, mean substrate size did not change in those streams over the same time period. Water chemistry in Big Creek was generally similar to its tributaries (Table 3). The large discharge in Big Creek (7.2 m^3/s compared to values that were generally <1 m^3/s) probably lowered some chemistry values, such as alkalinity, due to dilution. Except for the width and depth of Big Creek, the other physical habitat characteristics such as mean substrate size and embeddedness were also similar to the tributaries (Table 4). Habitat heterogeneity measures in Big Creek are similar to those recorded in 1988.

Mean values of periphyton chlorophyll-a decreased in all streams between 1996 and 1997 (Fig. 1). Periphyton chlorophyll-a values were the lowest recorded in the 9 year period for all streams except Cougar, which was more variable than the other sites (Fig. 1). Again, these reductions often suggest scouring flows, however periphyton ash-free dry mass (AFDM) remained the same or increased in all streams except Goat, between 1996 and 1997 (Fig. 2). The large AFDM values may indicate that non-algal organic matter comprised a large portion of the periphyton sampled. Among the sites sampled in 1997, periphyton chlorophyll-a and AFDM values were lowest in Goat Creek due to the dense riparian vegetation (Fig. 3). Values were low in the burned streams (Cliff and Cougar) and increased in the larger streams (Rush and Big Creek). Mean periphyton chlorophyll-a in Big Creek was average when compared to the other streams (Fig. 3) but AFDM in Big Creek was three times the AFDM in any other stream. Mean periphyton chlorophyll-a and AFDM in Big Creek was lower than that recorded in 1988, but had a large standard deviation. Mean benthic organic matter (BOM) associated with the Surber samples was low in the Big Creek tributary streams compared to the previous three years, but highly variable (Fig. 4). The mean BOM value in Big Creek for 1997 was lower than the 1988 mean. Among the sites sampled in 1997, BOM is highest in Goat Creek, the stream with the most dense riparian vegetation (Fig. 5). In addition, mean BOM is lower in the burned streams, Cliff and Cougar, than the reference stream, Cave Creek. BOM increases and becomes more variable as stream size increases (Rush and Big Creek) (Fig. 5).

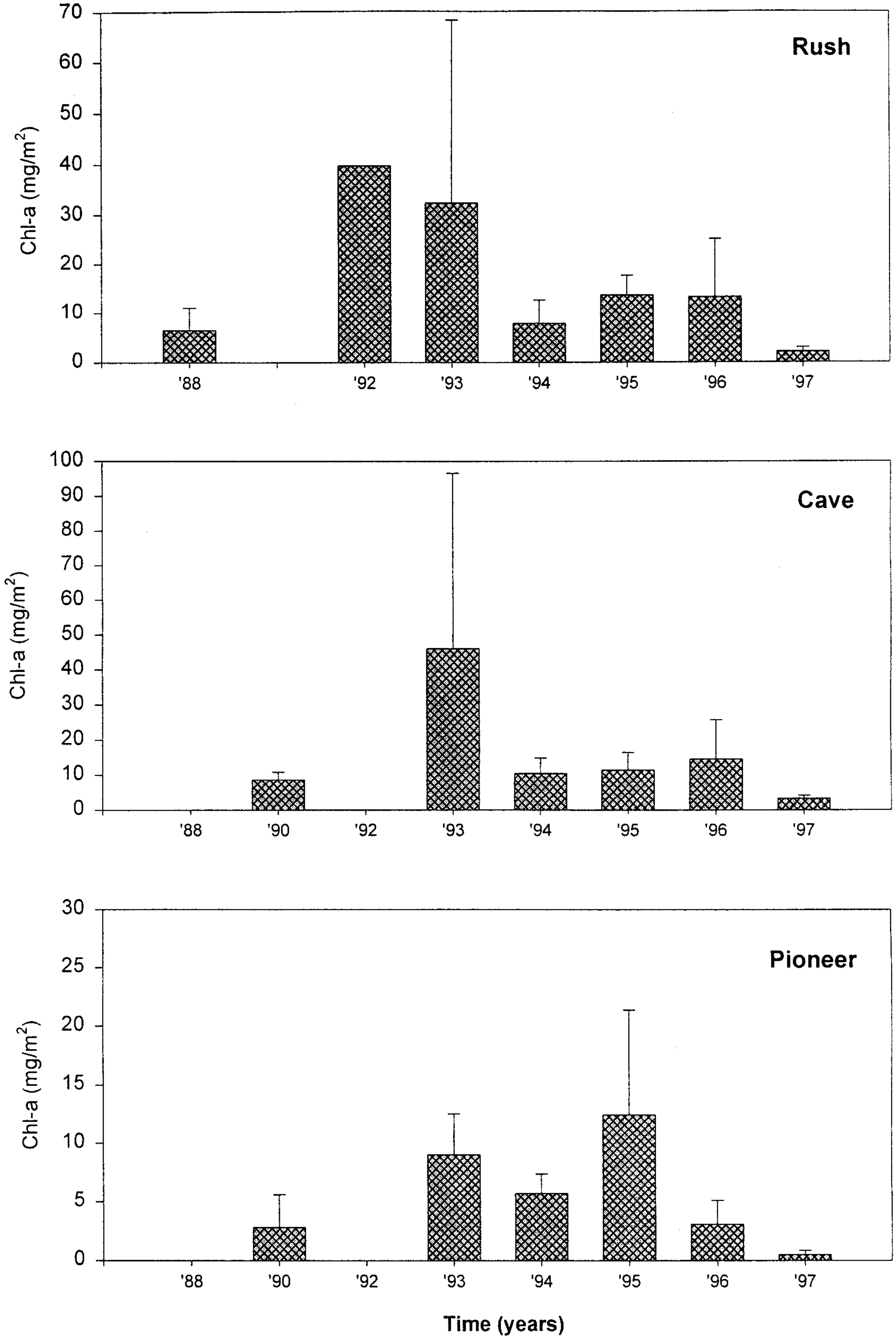
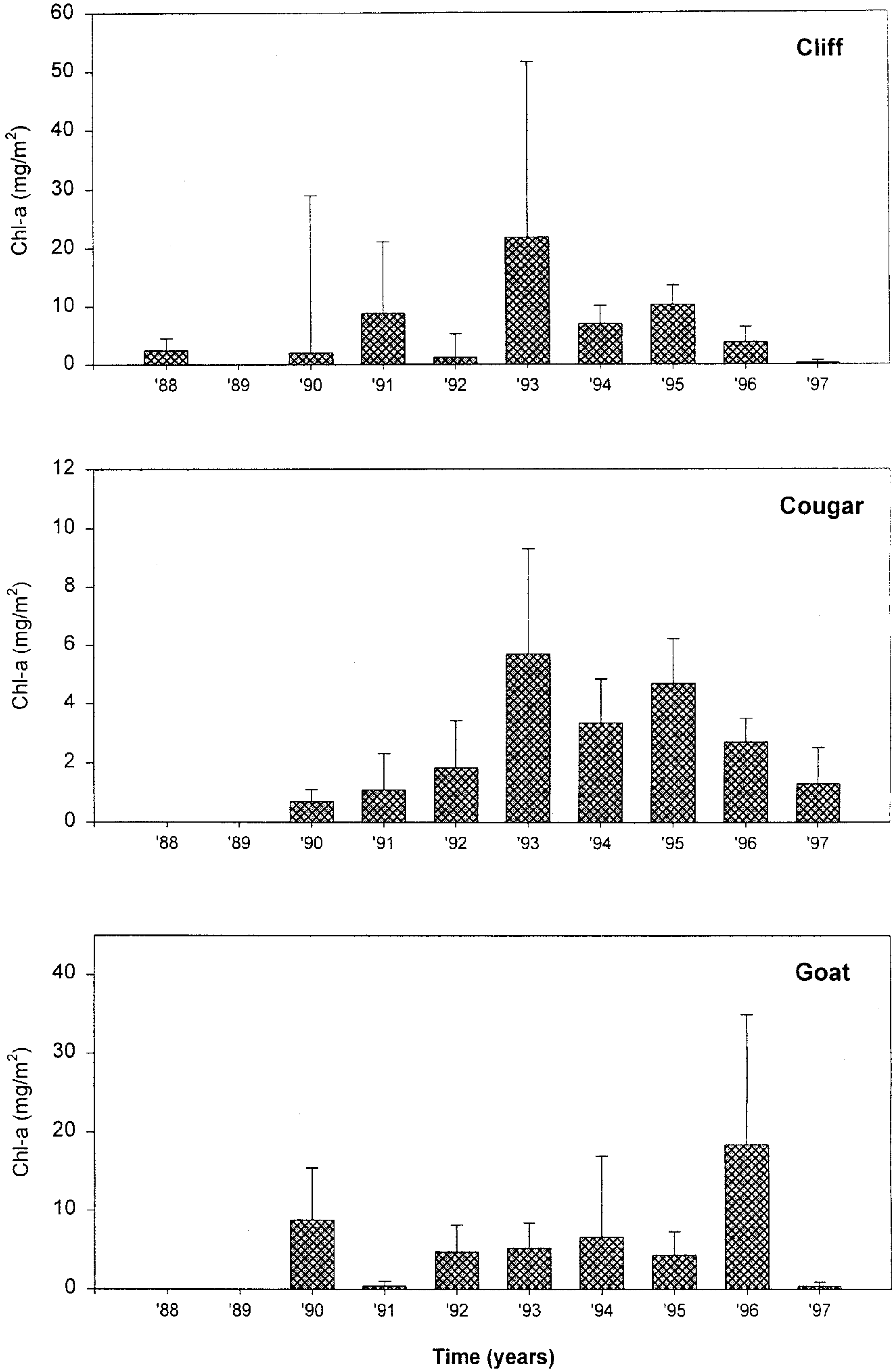


Figure 1. Mean values of periphyton chlorophyll *a* for the study streams. Error bars equal +1SD from the mean, n=5. Note the different scales on the y axis.



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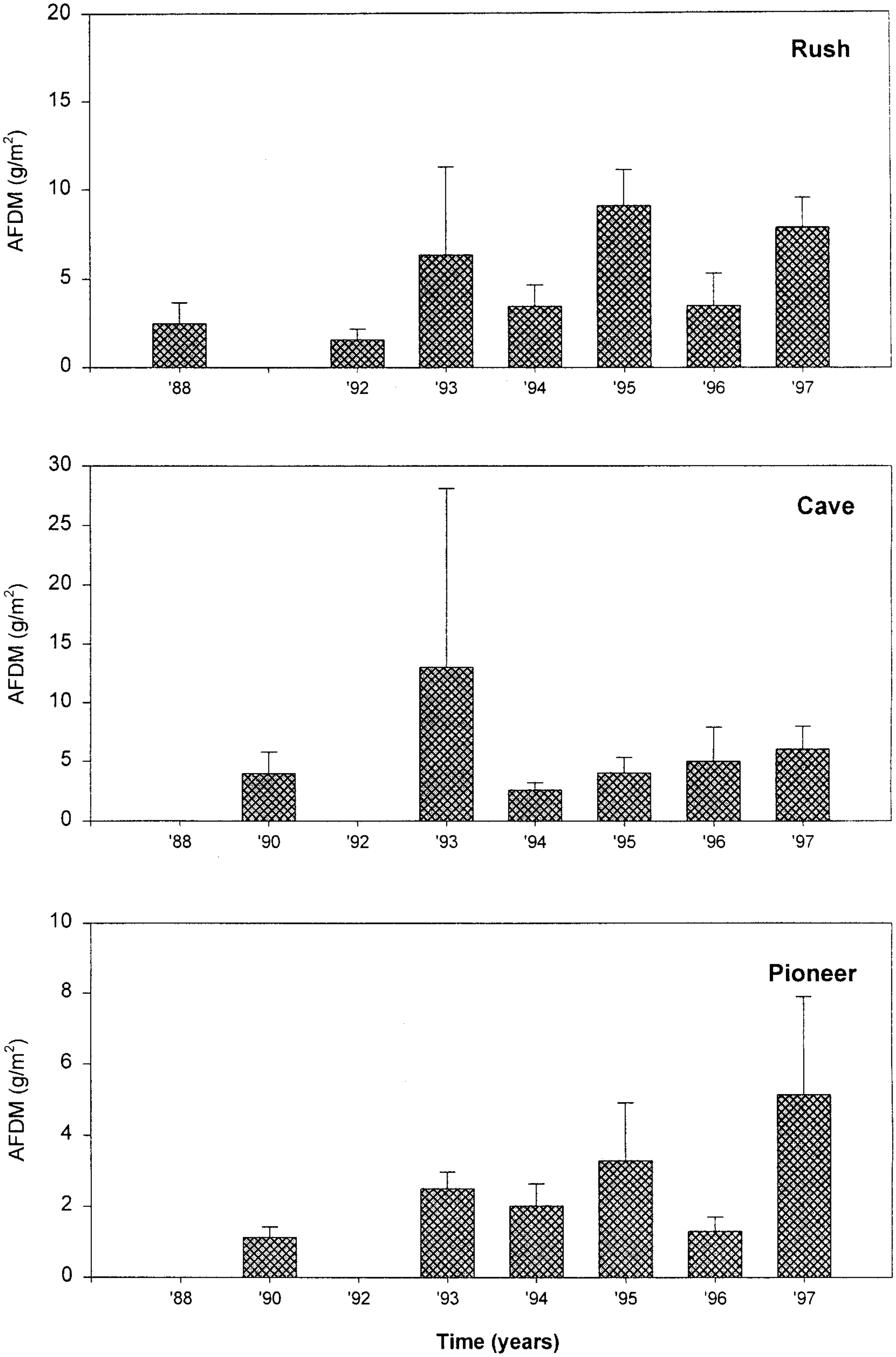
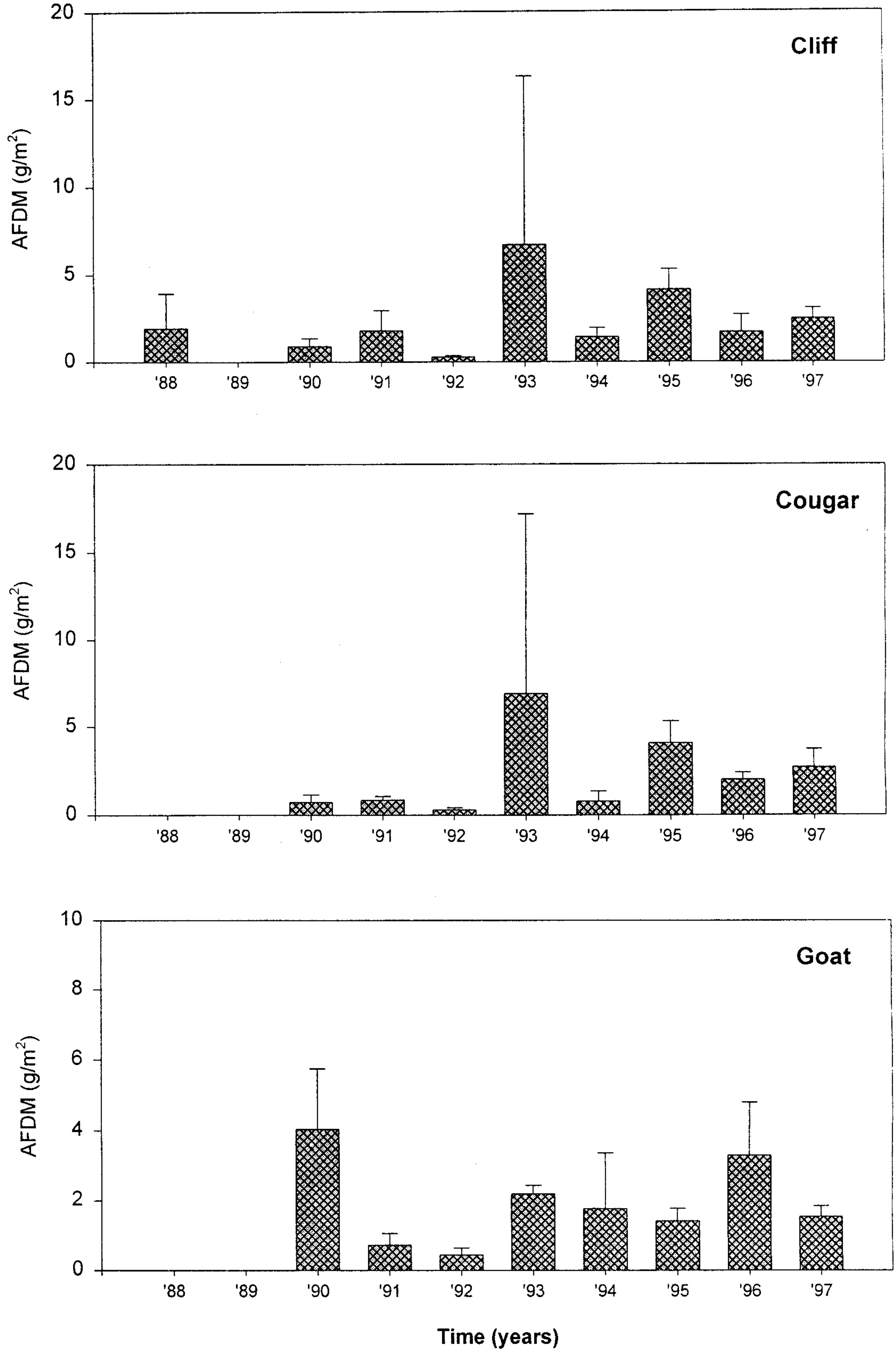


Figure 2. Mean values of periphyton ash-free dry mass (AFDM) for the study streams. Error bars equal +1SD from the mean, n=5. Note the different scales on the y axis.



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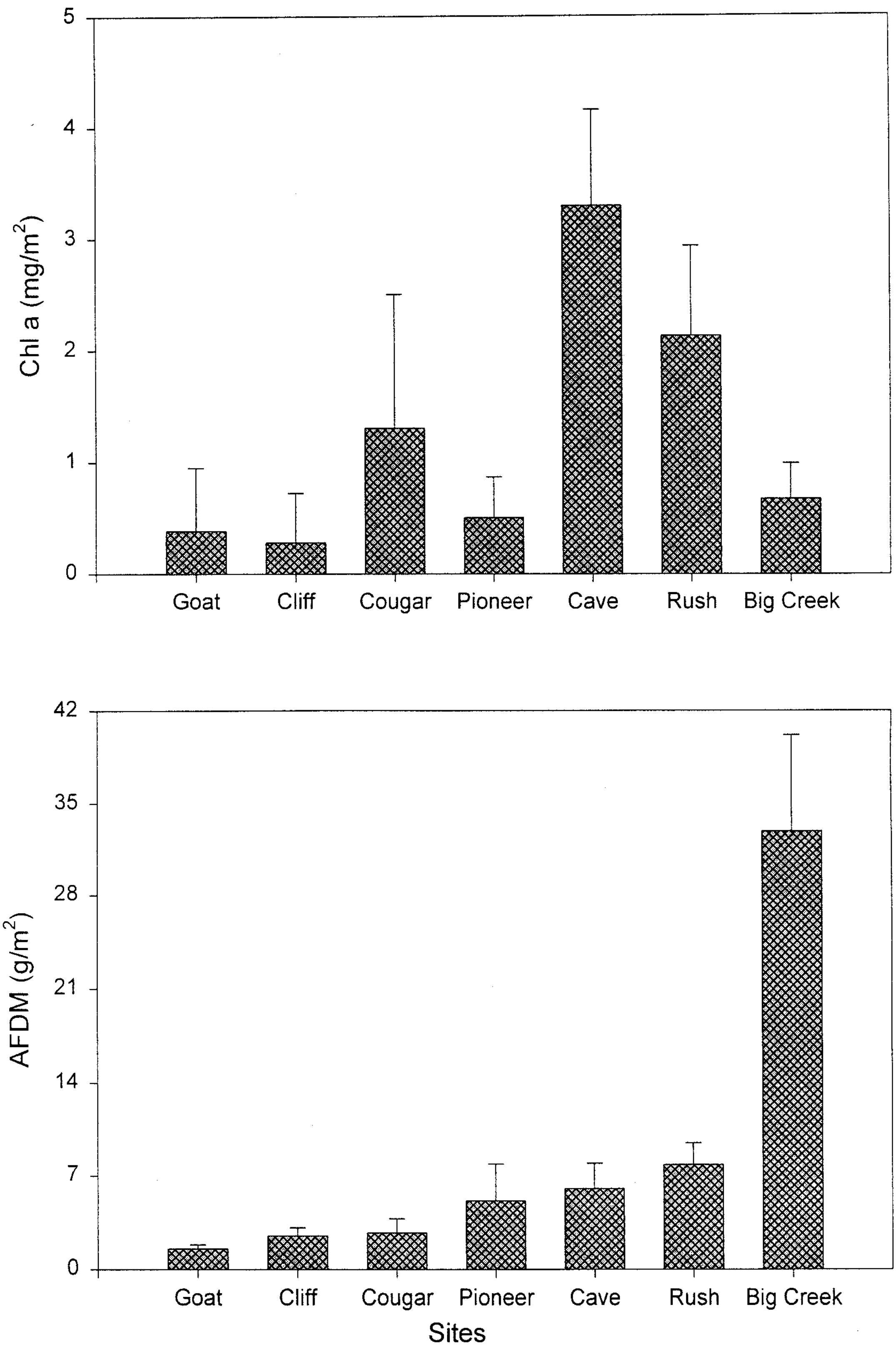

Figure 3. Periphyton chl a and AFDM from Big Creek and it's tributaries in 1997.

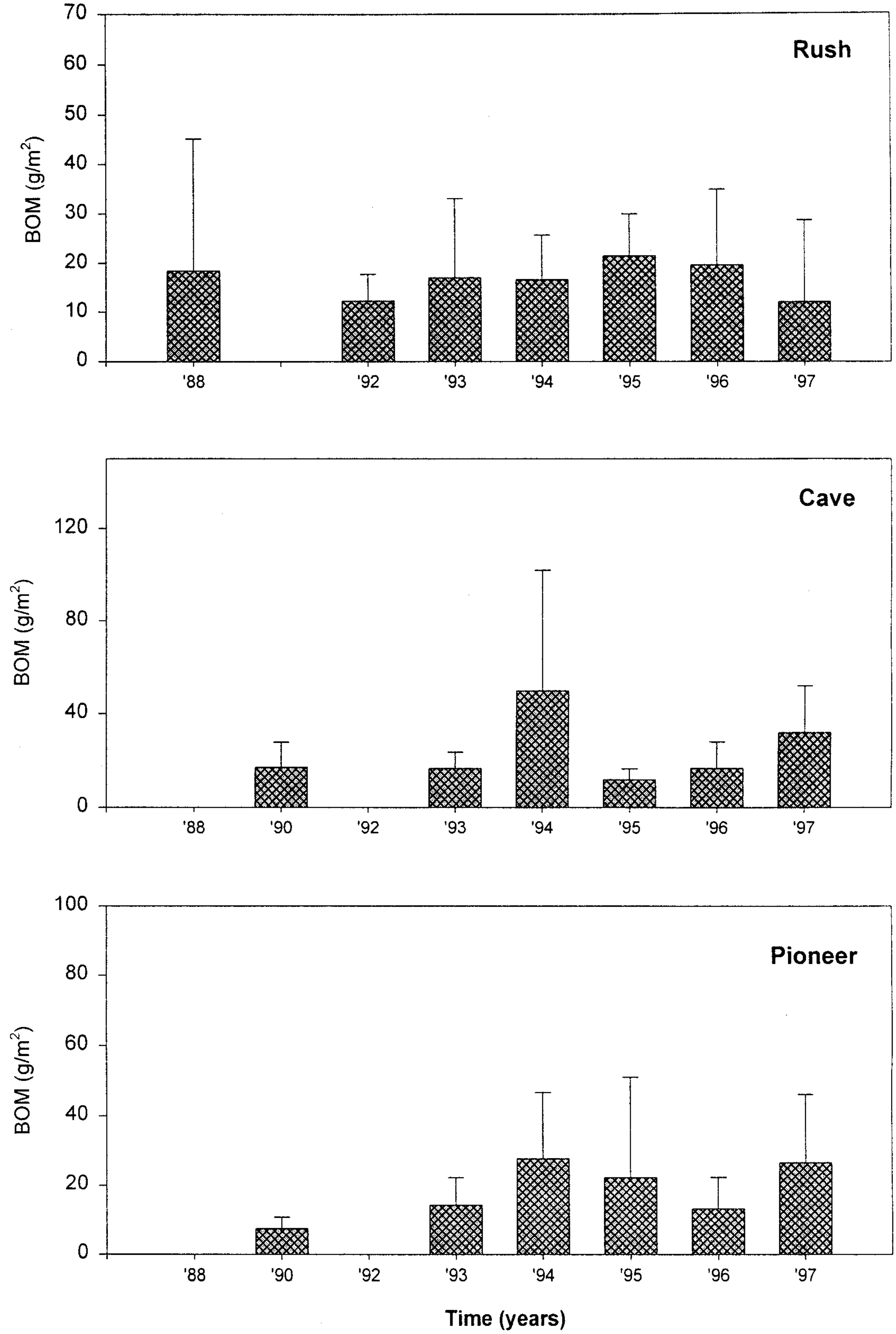

Figure 4. Mean values of benthic organic matter (BOM). Error bars equal +1SD from the mean, n=5. Note the different scales on the y axis.

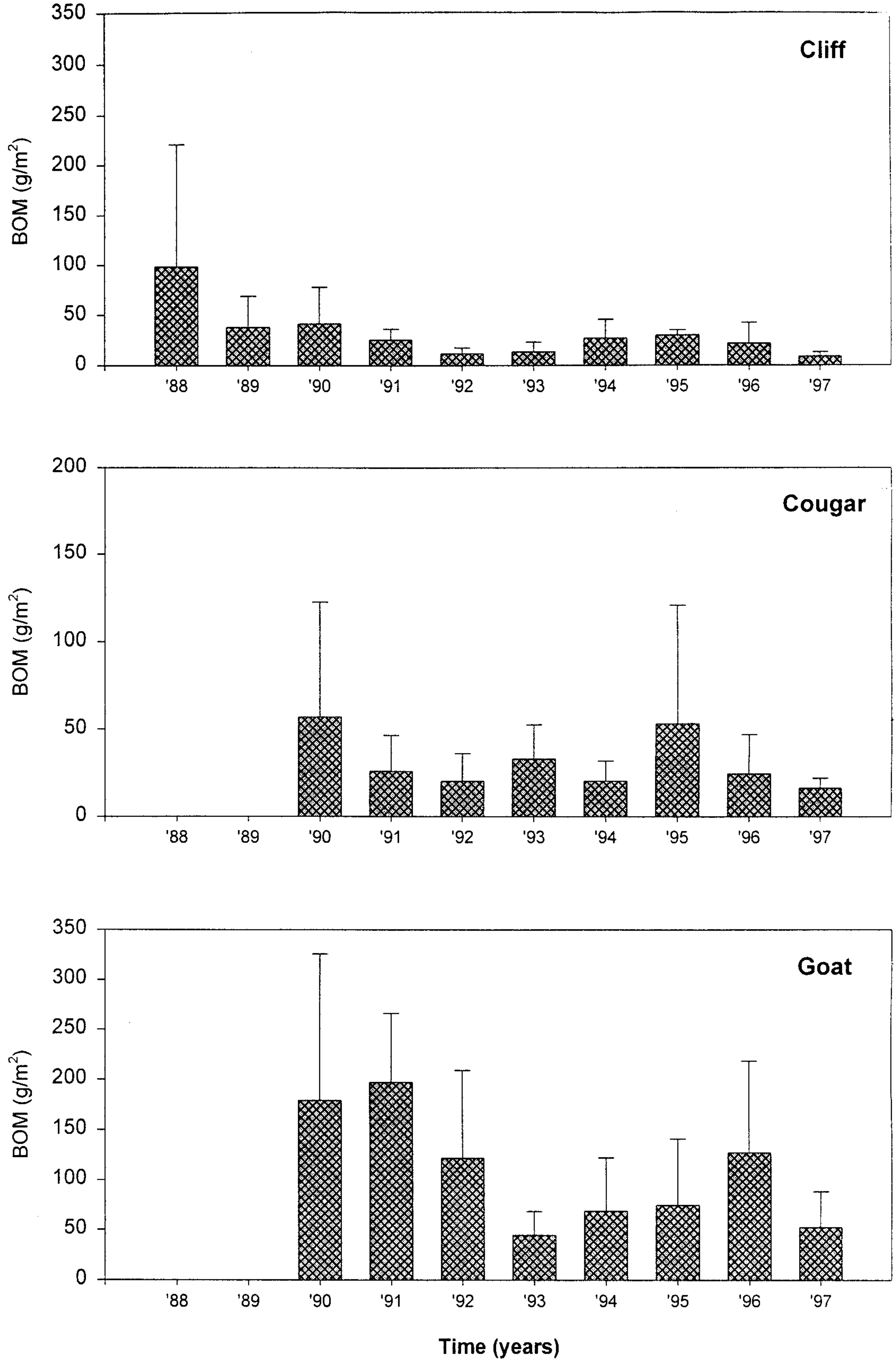

Figure 4 continued.

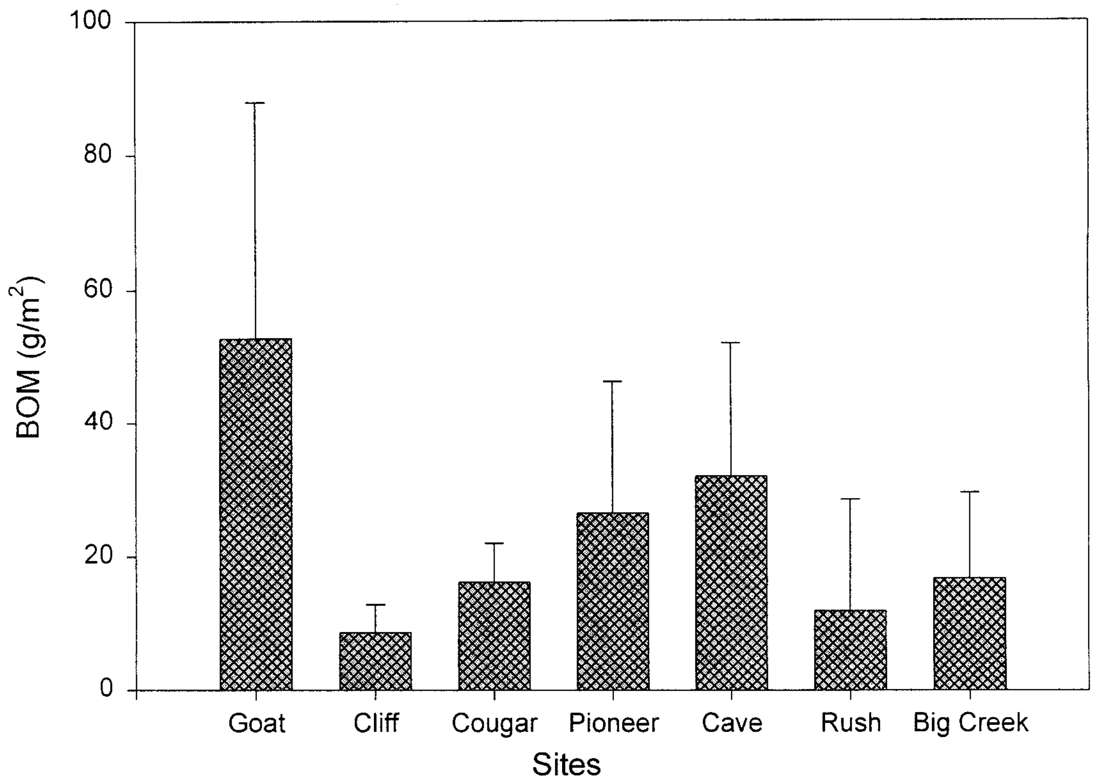

Figure 5. Benthic organic matter (BOM) from the sites sampled in 1997.
Error bars equal +1SD from the mean, n=5.

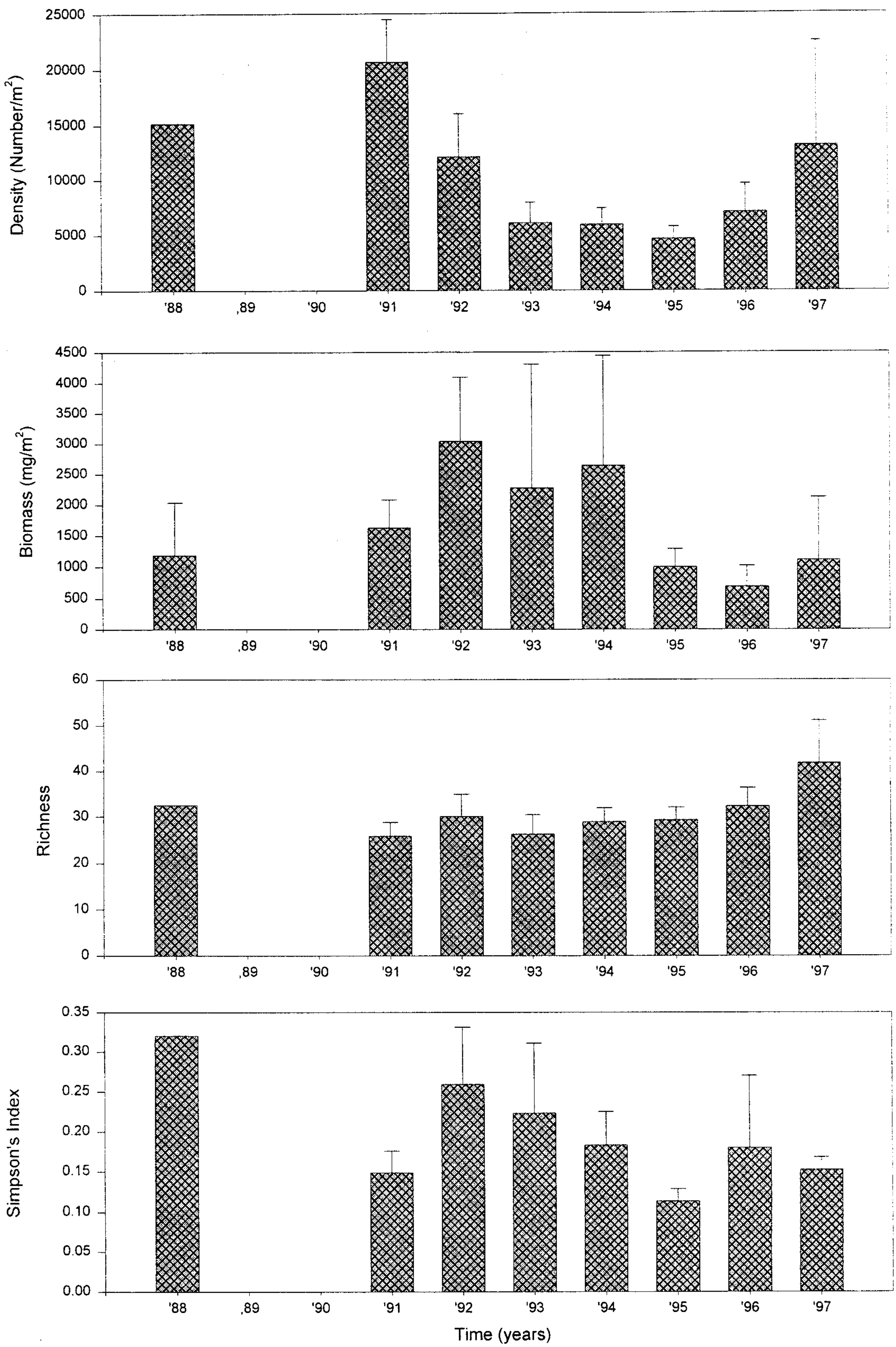

Figure 6. Macroinvertebrate density, biomass, taxa richness and Simpson's Index for Rush Creek. Error bars equal +1SD from the mean, n=5.

Aquatic macroinvertebrate density in Rush Creek was slightly greater in 1997 than in 1996 but was highly variable (Fig. 6). For the four years (1993-96), density in Rush ranged from approximately 5,000-9,000 individuals/m^2, this increased to 13,000 individuals/m^2 in 1997. Biomass has shown a variable pattern, both over time and within replicate samples. Over the entire course of the study, taxa richness in Rush had remained stable with mean values of 25-30 taxa, but increased to over 40 taxa in 1997. Simpson's Index, which takes into account the relative abundance of individual taxa, has been more variable over time than has taxa richness (Fig. 6). Density in Pioneer Creek decreased from 10,000 individuals/m^2 during 1996 to approximately 3,000 individuals/m^2 in 1997 (Fig. 7). This value is similar to values recorded in the years 1993-95 in Pioneer Creek. Biomass and taxa richness also showed decreases from 1996 to 1997 in Pioneer. Density in Cave Creek was >10,000 individuals/m^2 in 1996, approximately twice as large as the values measured from 1993-95 and in 1997 (Fig. 8). Despite the fluctuations in invertebrate density, biomass remained fairly constant from 1995 to 1997. Like Rush Creek, Cave showed an increase in richness and a decrease in Simpson's Index between 1996 and 1997.

Macroinvertebrate density in Cliff Creek has fluctuated from approximately 3,000-5,000 individuals/m^2 since the outset of the study in 1988 (Fig. 9). Biomass also has remained relatively stable over the course of the study. Mean taxa richness has ranged from a low value of approximately 20 taxa in 1993 to a high of 30 in 1996. Simpson's Index has been the most variable of the community measures, although the values have been low (= high diversity) throughout the study (Fig. 10). All community metrics were not significantly different between 1996 and 1997. Mean density and biomass in Cougar decreased slightly in 1997 from the previous five years (Fig. 10). Similar to Cliff Creek, species richness and Simpson's Index in Cougar has been variable but with consistently low values. Goat Creek has typically displayed the lowest invertebrate density, biomass, and diversity of any of the streams sampled. Density in Goat increased slightly from 1996 to 1997, with a mean value of approximately 1,500 individuals/m^2 (Fig. 11). Mean biomass remained constant from 1996 to 1997. Taxa richness in Goat during 1997 was more than twice the average (15) for previous years at 36 taxa (Fig. 11)

The relative abundance of the 15 most common invertebrate taxa in each stream are given in Table 5. The relative abundance of the most dominant taxon ranged from 19% in Pioneer

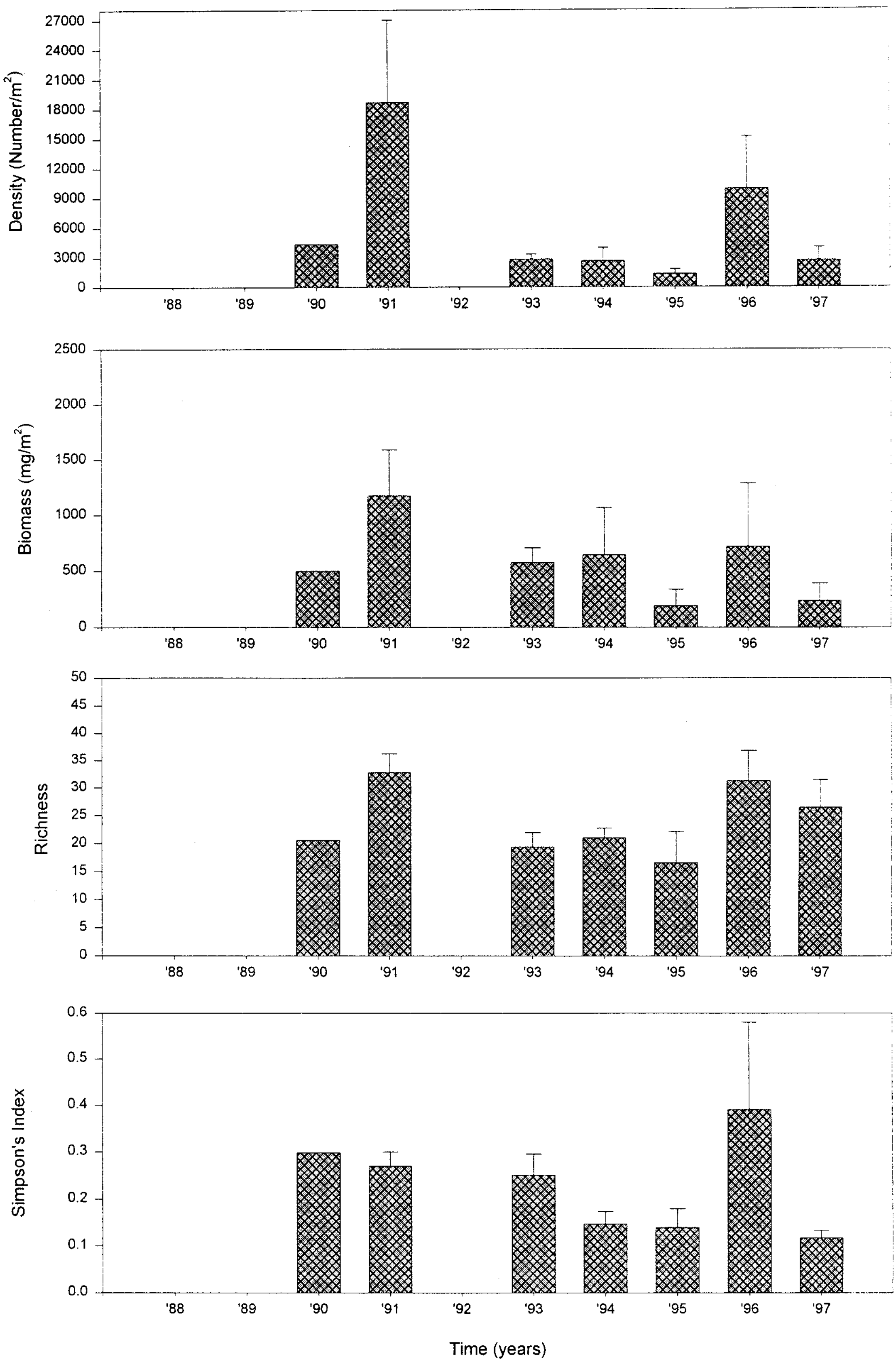

Figure 7. Macroinvertebrate density, biomass, taxa richness and Simpson's Index for Pioneer Creek. Error bars equal +1SD from the mean, n=5.

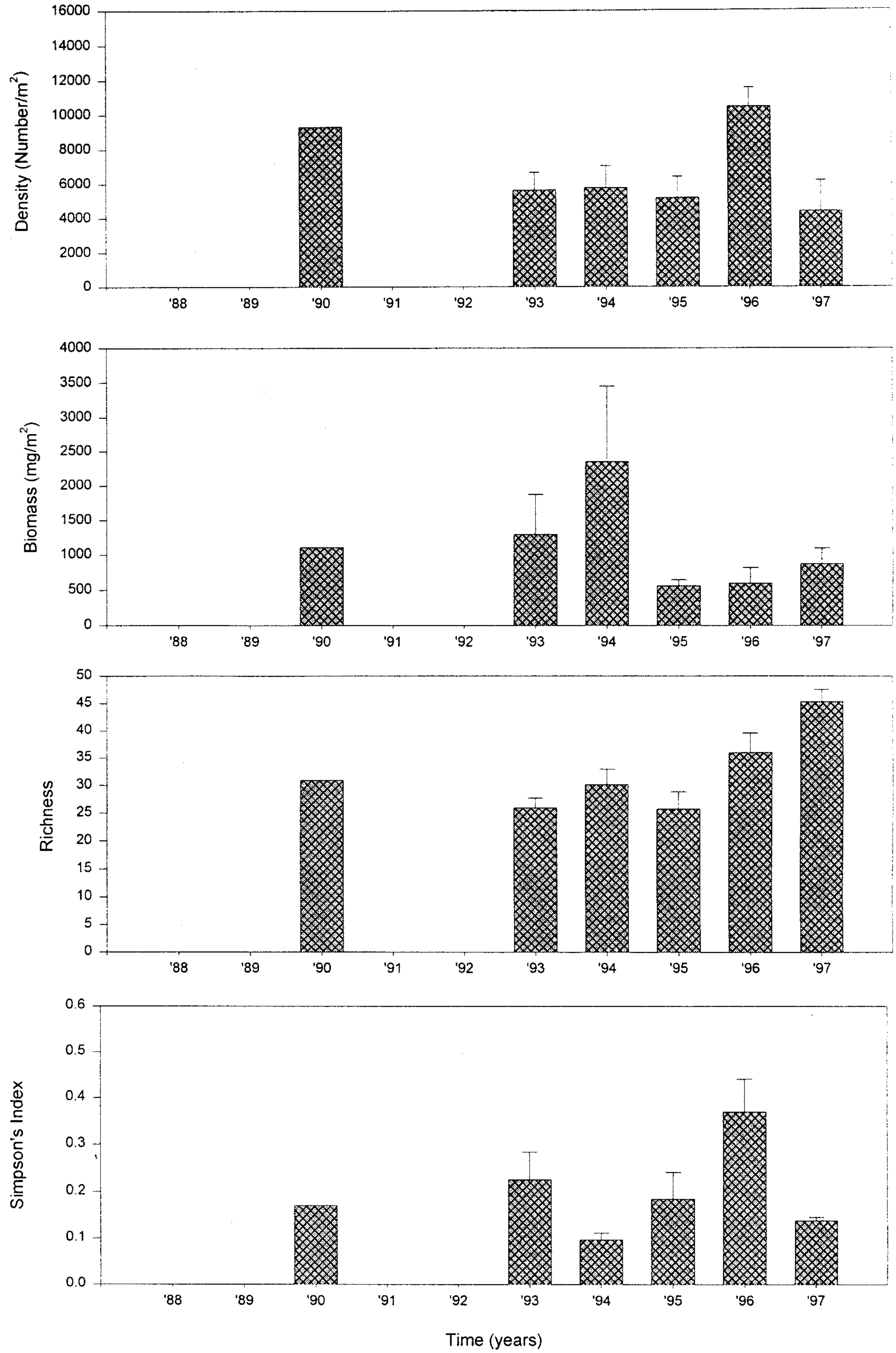

Figure 8. Macroinvertebrate density, biomass, taxa richness and Simpson's Index for Cave Creek. Error bars equal +1SD from the mean, n=5.

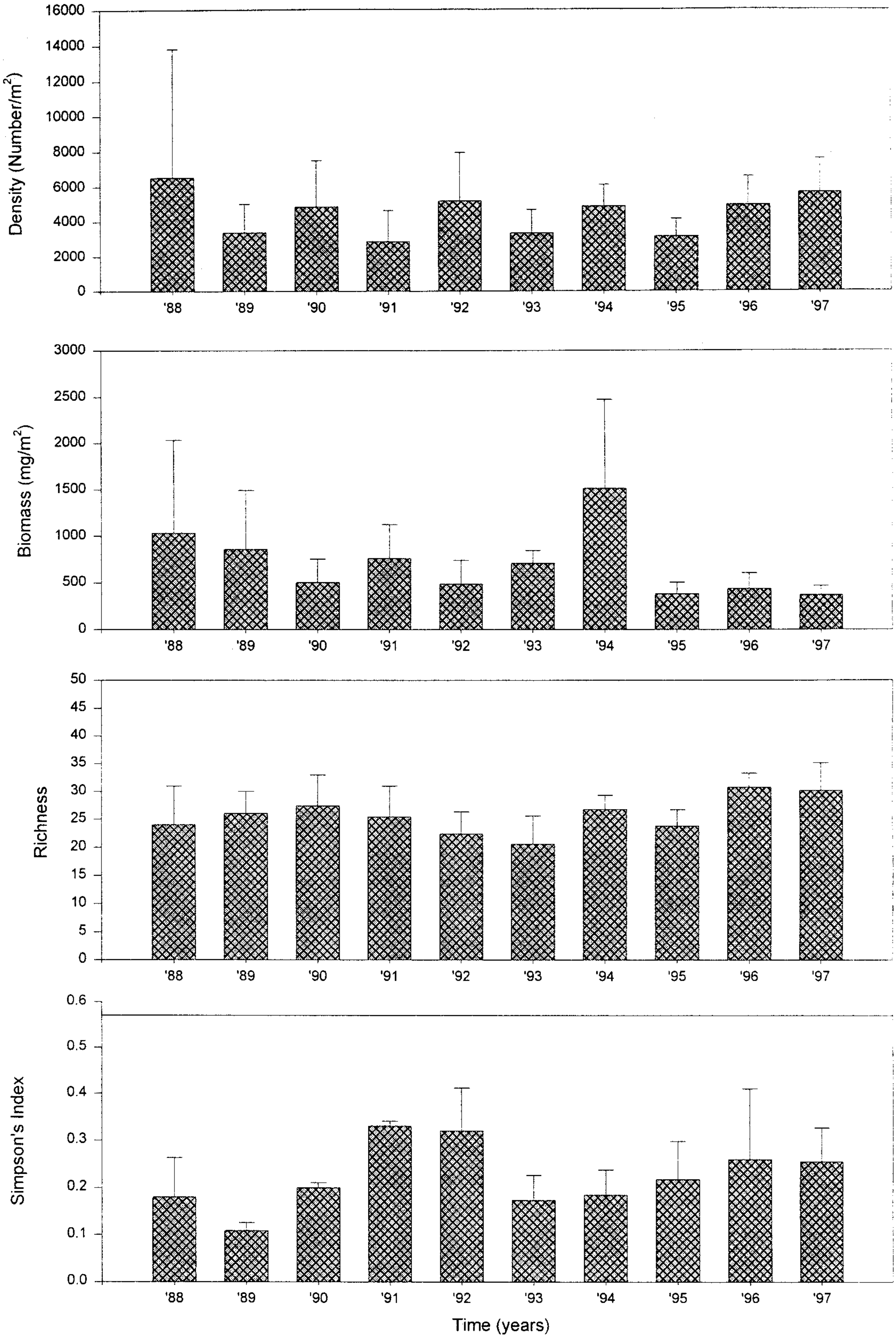

Figure 9. Macroinvertebrate density, biomass, taxa richness and Simpson's Index for Cliff Creek. Error bars equal +1SD from the mean, n=5.

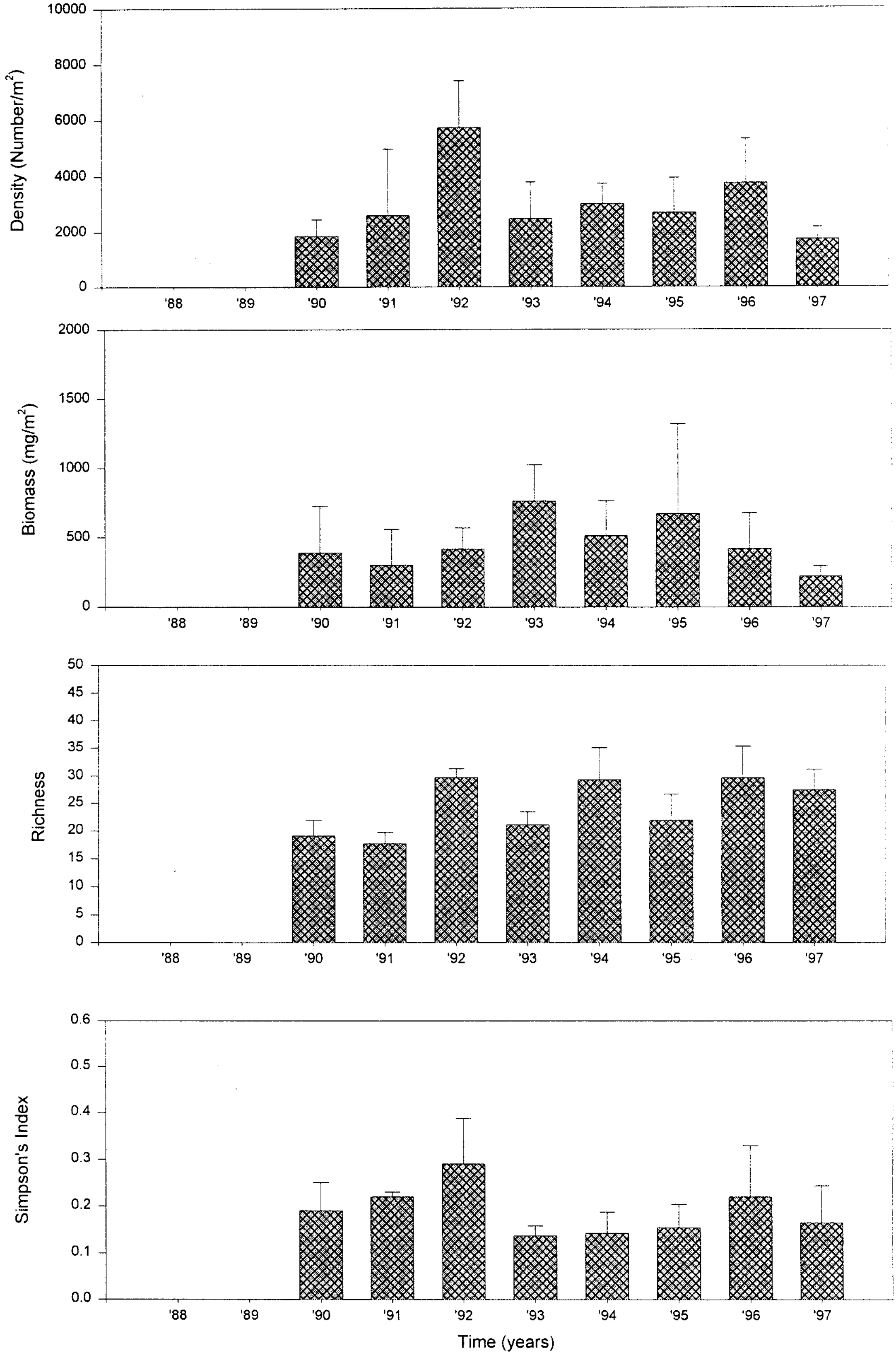

Figure 10. Macroinvertebrate density, biomass, taxa richness and Simpson's Index for Cougar Creek. Error bars equal +1SD from the mean, n=5.

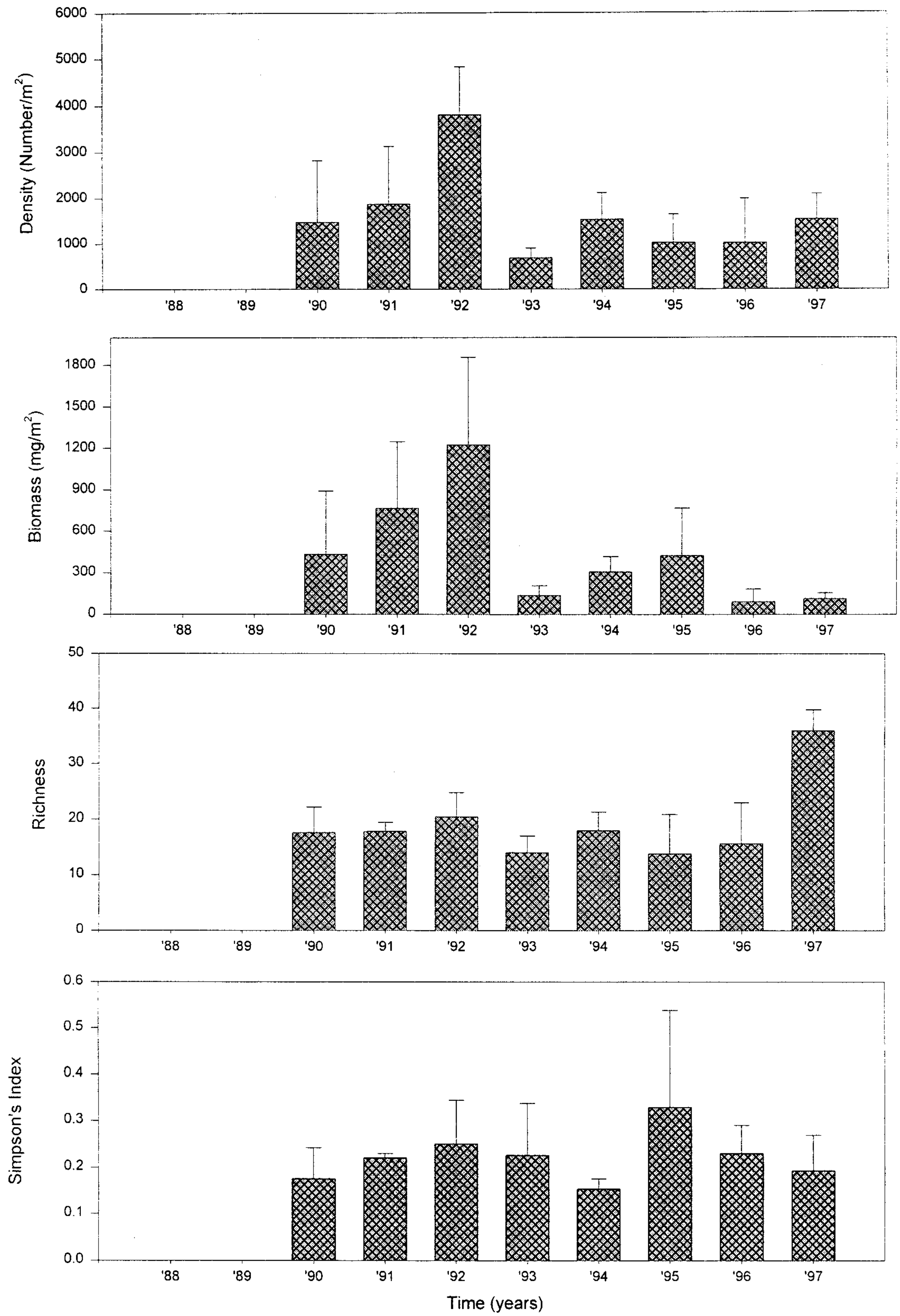

Figure 11. Macroinvertebrate density, biomass, taxa richness and Simpson's Index for Goat Creek. Error bars equal +1SD from the mean, n=5.

Table 5. Relative abundances of the 15 most common macroinvertebrate taxa from each stream, 1997. SD = one standard deviation from the mean, n = 5.

Rush

	Mean	SD
Oligochaeta	0.210	0.053
Chironomidae	0.197	0.032
Baetis	0.194	0.069
Hydracarina	0.106	0.062
Cinygmula	0.057	0.016
Epeorus	0.039	0.017
Heptageniidae	0.018	0.014
Acentrella	0.018	0.010
Serratella tibialis	0.016	0.009
Optioservus	0.014	0.007
Suwallia	0.012	0.007
Drunella doddsi	0.012	0.006
Simulium	0.012	0.007
Nemouridae	0.011	0.006
Heterlimnius	0.010	0.002

Cave

	Mean	SD
Baetis	0.274	0.053
Heterlimnius	0.108	0.017
Chironomidae	0.103	0.075
Hydracarina	0.100	0.044
Oligochaeta	0.067	0.076
Serratella tibialis	0.057	0.028
Cinygmula	0.028	0.009
Simulium	0.026	0.020
Sweltsa	0.023	0.002
Brachycentrus americanus	0.016	0.006
Epeorus	0.014	0.009
Zapada	0.013	0.010
Dolophilodes	0.013	0.011
Glutops	0.011	0.007
Epeorus deceptivus	0.011	0.011

Pioneer

	Mean	SD
Baetis	0.193	0.098
Epeorus	0.100	0.055
Sweltsa	0.088	0.036
Zapada	0.088	0.019
Chironomidae	0.077	0.087
Cinygmula	0.076	0.041
Rhithrogena	0.065	0.023
Heterlimnius	0.038	0.027
Hydracarina	0.037	0.018
Arctopsyche grandis	0.034	0.068
Perlidae	0.034	0.010
Ryacophila betteni	0.020	0.006
Capniidae	0.018	0.020
Ostracoda	0.016	0.016
Ryacophila brunnea	0.014	0.007

Cliff

	Mean	SD
Oligochaeta	0.456	0.093
Nemouridae	0.107	0.077
Baetis	0.083	0.021
Epeorus	0.062	0.020
Taenionema	0.038	0.036
Rhithrogena	0.034	0.017
Zapada	0.030	0.022
Cinygmula	0.029	0.004
Heterlimnius	0.025	0.011
Chironomidae	0.019	0.012
Drunella doddsi	0.017	0.010
Sweltsa	0.011	0.005
Arctopsyche grandis	0.010	0.011
Taeniopterygidae	0.009	0.019
Ryacophila brunnea	0.007	0.004

Cougar

	Mean	SD
Baetis	0.221	0.095
Heterlimnius	0.163	0.185
Nemouridae	0.149	0.053
Chironomidae	0.075	0.043
Zapada	0.054	0.034
Cinygmula	0.047	0.008
Ostracoda	0.031	0.025
Oligochaeta	0.028	0.046
Rhyacophila	0.026	0.025
Hydracarina	0.025	0.012
Epeorus longimanus	0.015	0.017
Simulium	0.014	0.013
Hydropsychidae	0.011	0.008
Epeorus	0.010	0.006
Epeorus deceptivus	0.010	0.019

Goat

	Mean	SD
Chironomidae	0.232	0.132
Heterlimnius	0.195	0.225
Baetis	0.086	0.048
Hydracarina	0.064	0.033
Elmidae	0.059	0.091
Zapada	0.056	0.040
Ostracoda	0.049	0.031
Nemouridae	0.030	0.018
Simulium	0.024	0.027
Pericoma	0.020	0.016
Collembola	0.020	0.040
Drunella coloradensis	0.017	0.014
Ceratopogonidae	0.015	0.011
Dixa	0.014	0.014
Sweltsa	0.009	0.009

Table 5 continued.

Big Creek

	Mean	SD
Chironomidae	0.389	0.048
Brachycentrus occidentalis	0.098	0.051
Baetis	0.090	0.013
Heptageniidae	0.085	0.021
Simulium	0.048	0.034
Hydracarina	0.044	0.012
Perlodidae	0.018	0.009
Acentrella	0.018	0.015
Serratella	0.016	0.012
Hydropsychidae	0.016	0.008
Diphetor hageni	0.015	0.014
Epeorus longimanus	0.013	0.005
Hexatoma	0.012	0.005
Taeniopterygidae	0.012	0.008
Optioservus	0.012	0.010

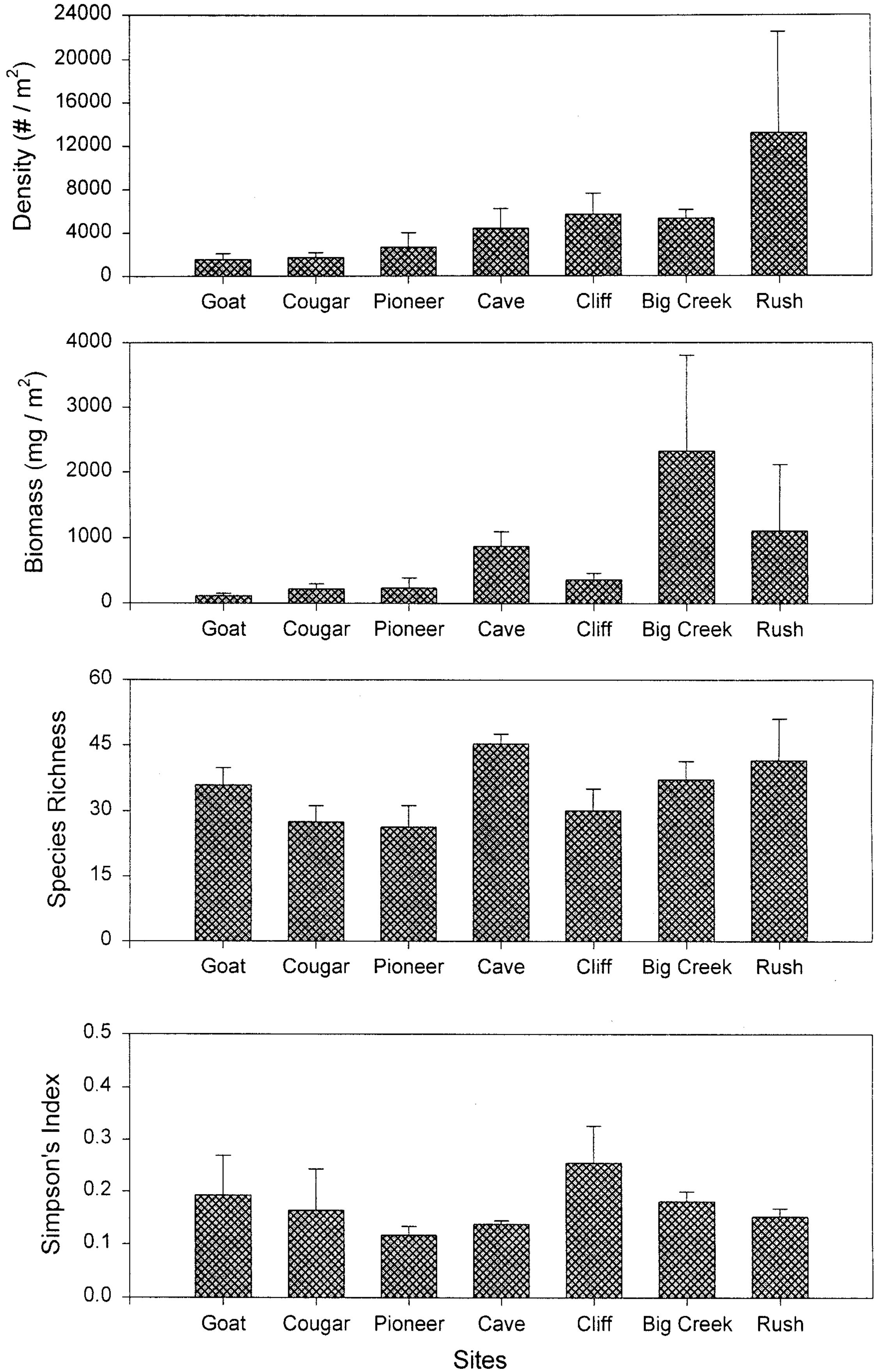

Figure 12. Macroinvertebrate density, biomass, taxa richness and Simpson's Index for Big Creek and its tributaries. Error bars equal +1SD from the mean, n=5,

Creek to 46% in Cliff Creek. During 1996, Oligochaeta was often the most abundant taxon in all streams except Goat Creek. In 1997, Oligochaeta was only dominant in Cliff and Rush Creeks. Other common taxa in 1997 included *Heterlimnius*, *Baetis*, *Epeorus*, Chironomidae and Hydracarina. In general, the taxa which constitute the majority of the invertebrate community have not changed substantially over the past 2-3 years (see Royer and Minshall 1996, Royer et al. 1995).

At the Big Creek site, invertebrate density was approximately 5,000 individuals/m^2 which is average compared to the other streams in the catchment (Fig 12). Biomass however, was twice that of the next closest stream, Rush Creek and 20 times that of Cougar and Goat Creeks. Mean taxa richness and Simpson's Index values for Big Creek were average compared to the other streams (Fig. 12). Chironomidae made up 39% of the macroinvertebrates (Table 5). *Baetis*, *Brachycentrus occidentalis* and Heptageniidae each comprised approximately 10% of the abundance.

DISCUSSION

Royer and Minshall (1996) concluded that chemical and physical conditions in Cliff, Cougar, and Goat had not been measurably altered by the Golden Fire of 1988. It was hypothesized that these streams might, however, respond differently to the floods during the spring of 1997 than would the unburned streams (Royer and Minshall 1996). Our research during the summer of 1997 showed only minor evidence that the burned streams were scoured to a greater extent than were the unburned streams. Bankfull discharge was not significantly different than previous years. However, mean substrate embeddedness decreased significantly in Goat Cougar, Cliff, and Pioneer Creeks (see Table 4) and might indicate scouring of the channels in these systems. However, the average substrate size was not altered (and the BOM was too variable to draw any conclusions), as might be expected following severe flooding. It appears that the Golden and the Rush Point Fires have not, to date, been a major influence on the physical and chemical habitat of Cliff, Cougar, Goat, Pioneer or Rush Creeks.

The severity of a given disturbance on the ecological conditions of a stream ecosystem can be gaged by determining if the event resulted in conditions outside the normally observed range of variability. In this regard, one goal of this research is to define the natural range of variability that occurs in wilderness streams. The abundance and diversity of aquatic macroinvertebrates provides an ecological assessment for each of the study streams. Repeated sampling of the systems allows for determination of the long-term mean and the variability around that mean for particular variables. For study streams in the Big Creek catchment, density tends to vary around a long-term mean of 4,000 to 5,000 individuals/m^2 (see Figs 6-11). Taxa richness is, in part, a function of stream size (Minshall et al. 1985), and this can be seen in the long-term mean taxa richness for Rush Creek versus Cliff Creek and Cougar Creek. Rush, the largest of these streams, typically has about 35 taxa, whereas Cliff and Cougar (both smaller than Rush) have about 28 taxa. This difference is not large, but it is consistent over 7-9 years of study. Long-term trends such as these provide important assessment tools for resource managers.

Taxa richness also was the most temporally stable community variable measured in all of the streams. Taxa richness generally has the lowest variance associated with it and is the community metric that has varied the least over the nine year study period. The spatial and temporal consistency observed in taxa richness suggests it may be an excellent metric for determining if perturbations have occurred in a given stream, and if so, the severity of the impact.

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